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[001] MULTISPEED MANUAL TRANSMISSION

[002]

[003]

[004] According to the preamble of claim 1, this invention relates to a multispeed manual transmission comprising one input shaft, countershafts, gears and/or idle gears non-rotatably connectable via shifting clutches with the countershafts for gear or direction change being disposed upon the countershafts and one output shaft.

[005]

[006] The transmissions that are usually employed in dumpers, loaders, excavation loaders and lift trucks, and also used in vehicles operated on the road such as mobile cranes. Here are involved, as a rule, powershift transmission with front-mounted hydrodynamic torque converters where a continuous and automatic torque increase can be obtained during an increase of the working resistance of the motor vehicle such as a construction machine. Driving torques of the transmission can be produced driving torques of the transmission which correspond to about a triple value of the motor torque.

[007] The power flow in the individual gears of a transmission of the above mentioned kind is produced by a combination of the hydraulically shiftable clutches. The clutches must be shiftable under load for the reversal in loaders, among others, and therefore, can absorb much energy. The design of the housing and the arrangement of the shafts of the transmission must be adapted to the application.

[008] Within the scope of the Applicant's EP 0 759 129 B1 is described a multispeed reverse transmission shiftable under load having at least one input shaft, countershafts and gears which form an input gearset and shifting clutches situated on the countershafts with idle gears which can optionally be no-rotatably connected with one of the countershafts for gear and direction change. One fixed gear and idle gears in constant mesh therewith form the input gearset; in addition, one fixed gear situated on a countershaft and inconstant mesh with two idle gears

form an output gear chain; the countershafts are interconnected by fixed gears and one idle gear. Another such transmission is the object of the Applicant's EP 0 796 400 B1.

[009] The problem on which this invention is based is to outline a shiftable multispeed reverse transmission having a higher power compared to the prior art. Besides, the inventive transmission must have good efficiency and be sturdy.

[010] This problem is solved by the features of claim 1. Other developments and advantages result from the sub-claims.

[011]

[012] Accordingly, a transmission shiftable under load is proposed which comprises one input shaft, countershafts, gears and/or idle gears non-rotatably connected with the countershafts, via shifting clutches, for gear and direction change being located on the countershafts, and one output shaft, the reduction ratio is generated by spur pinion stages and at least one shiftable planetary stage.

[013] According to the invention, depending on the clutch states, two power lows are produced which respectively meet on the same fixed gear. The planetary stage is preferably in power flow direction located between the fixed gear and the output shaft. Depending on the transmission version, the transmission can be designed as a four-gear or as an eight-gear transmission.

[014]

[015] The invention is explained in detail by way of example with reference tot he enclosed Figures which show:

[016] FIG. 1 is a diagram of an inventive transmission especially adequate for a loader;

[017]

[018] FIG. 2 is a diagram of an inventive transmission especially adequate for a dumper;

[019]

[020] FIG. 3 is a preferred embodiment of the bearing arrangement for the shaft having the planetary stage.

[021]

[022] The transmission shown in FIG. 1, which is especially adequate for a loader, comprises one input shaft 1 upon which is situated one powershift clutch KV (forward clutch) by way of which an idle gear 115 can be non-torsionally connected with the input shaft 1. Upon the shaft 1 is, in addition, provided with one fixed gear 116, which is in constant mesh with a fixed gear 202 of a countershaft 2. Upon the countershaft 2 is provided one powershift clutch KR (reverse clutch) which loosely non-torsionally connects an idle gear 102 with the countershaft 2. The idle gear 102 and the idle gear 115 of the input shaft are in constant mesh with a fixed gear 104 upon a countershaft 4; upon the countershaft 4 are additionally provided one idle gear 111 non-torsionally connectable with the countershaft 4 via a clutch K2 and one fixed gear 204, the idle gear 111 being in constant mesh with a fixed gear 106 located upon a countershaft 6 and the fixed gear 204 is in constant mesh with an idle gear 113 situated upon the countershaft 6. As is to be understood from FIG. 1, the idle gear 113 can be non-torsionally connected via a clutch K4 with the countershaft 6.

[023] The fixed gear 106 of the countershaft 6 is in constant mesh with a fixed gear 107 located on a countershaft 7. Upon the shaft 7 is provided one idle gear 117 which is in constant mesh with one fixed gear 108 situated on an output shaft 8. According to the invention, in power flow direction between the fixed gear 107 and the fixed gear 108 of the output shaft 8, a shiftable planetary stage P is situated, the sun gear of which is non-torsionally connected with the countershaft 7. One brake B is provided which connects a hollow gear H with a housing G. In addition, two components of the planetary stage, preferably the sun gear with the hollow gear, are loosely interconnectable via a clutch K. If the brake B is now engaged and the clutch K open, the power is then transmitted from the fixed gear 107, via the planetary stage P to the idle gear 117. On the other hand, when the brake B is disengaged and the clutch K engaged, the power is

directly transmitted from the fixed gear 107 to the idle gear 117 without any change of ratio. (The planetary stage rotates in the block operation.)

[024] This transmission has four forward and four reverse gears, two other shifting elements in two power flows being each alternatively actuated to implement the gears when the forward clutch KV is engaged for the forward gears and the reverse clutch KR for the reverse gears. The clutches KR and KV suffice to meet the reversal requirements placed on a loader, since they can be shifted under load. For the first forward gear, together with the clutch KV, the clutch K2 and the brake B are engaged, the gears 115, 104, 111, 106, 107, planetary stage, 117 and 108 transmitting the power to the output shaft. The second forward gear results by engaging the brake B and the clutch K4; the power is transmitted by the gears 115, 104, 204, 113, 106, 107, planetary stage, 117 and 108 to the output shaft. For the third forward gear, the clutches K2 and K are engaged, the gears 115, 104, 111, 106, 107, 117 and 108 transmitting the power to the output shaft 8. To engage the fourth forward gear, the clutches K4 and K are engaged so that the power is transmitted via the gears 115, 104, 204, 113, 106, 107, 117 and 108 to the output shaft 8.

[025] For the reverse gears, the clutch KR is engaged. The first reverse gear results here by engaging the clutch K2 and of the brake B; the power is transmitted from the input shaft 1 via the gears 116, 202, 102, 104, 111, 106, 107, planetary stage, 117 and 108 to the output shaft 8. The second reverse gear results by engaging the clutch K4 and of the brake B, the power being transmitted via the gears 116, 202, 102, 104, 204, 113, 106, 107, planetary stage, 117 and 108 to the output shaft 8. According to the invention, the third reverse gear is engaged by engaging the clutches K2 and K, the power being transmitted via the gears 116, 202, 102, 104, 111, 106, 107, 117 and 108 to the output shaft 8. Finally, for the fourth reverse gear, the clutches K4 and K are engaged; the gears 116, 202, 102, 104, 204, 113, 106, 107, 117 and 108 transmitting the power to the output shaft 8.

[026] According to the invention, therefore, depending on the clutch states two power flows can be produced which meet on the same fixed gear 107, the fixed gear not being situated upon the output shaft 8.

[027] By substituting for the clutches KV and KR through input shaft 1, two synchronizer units or dog clutches SV and SR and adding two other countershafts 3 and 5 with corresponding gears and clutches, an eight gear transmission advantageously results which is especially adequate for dumpers.

[028] One such transmission is the object of FIG. 2. The eight-gear transmission accordingly differs from the transmission shown in FIG. 1 by the fact that upon the countershaft 2, no shifting element is situated and that upon the input shaft, instead of the clutch KV, two synchronizer units or dog clutches SV and SR are placed (respectively for the forward and reverse gears, it being possible to shift when the vehicle is stopped). The synchronizer units or dogs can be designed as double or single synchronizer units or also as dog clutches. Further provided is one other countershaft 3 which has two fixed gears 103 and 203 and one idle gear 110 non-torsionally connectable with the countershaft 3 via a clutch K1 provided on the countershaft 3, the fixed gear 103 being in constant mesh with the idle gear 115 of the input shaft 1.

[029] One other countershaft 5 is, in addition, provided having one fixed gear 105 which is in constant mesh with the idle gear 110 of the countershaft 3 and one idle gear 112 non-torsionally connectable with the countershaft 5 via a clutch K3 provided on the countershaft 5. The idle gear 112 is here in constant mesh with the fixed gear 203 of the countershaft 3; the fixed gear 105 is in constant mesh with the fixed gear 107 disposed on the countershaft 7.

[030] To implement the eighth forward and eighth reverse gears, when the clutches SV and SR, respectively, for the forward and reverse gears are engaged, each two other shifting elements are alternatively actuated in two power flows. The first gear of the transmission, according to FIG. 1, corresponds here to the second gear, the second gear of the transmission to FIG. 1 to the fourth gear, the third gear of the transmission, according to FIG. 1, to the sixth gear and the fourth gear of the transmission, according to FIG. 1, to the eighth gear.

[031] Accordingly, the first forward gear results by engaging the SV, of the clutch K1 and of the brake B; the power is transmitted by the gears 115, 103, 110, 105, 107, planetary stage, 117 and 108. For the second forward gear, the clutch K2 of the brake B are engaged, the gears 115, 104, 111, 106, 107, planetary stage, 117 and 108 transmitting the power to the output shaft. In the third forward gear, the clutch K3 and the brake B are engaged and the power is transmitted by the gears 115, 103, 203, 112, 105, 107, planetary stage, 117 and 108. The fourth forward gear results by engaging the brake B and of the clutch K4; the power is transmitted by the gears 115, 103, 203, 112, 105, 107, planetary stage, 117 and 108 to the output shaft. In the fifth gear, the clutches K1 and K are engaged, the power being transmitted by the gears 115, 103, 110, 105, 107, 117 and 108 to the output shaft 8. According to FIG. 2, for the sixth forward gear the clutches K2 and K are engaged, the gears 115, 104, 111, 106, 107, 117 and 108 transmitting the power to the output shaft 8. In addition, the seventh forward gear results by engaging the clutches K3 and K; the power is transmitted by the gears 115, 103, 203, 112, 105, 107, 117 and 108. To engage the eighth forward gear, the clutches K4 and K are engaged so that the power is transmitted via the gears 115, 104, 204, 113, 106, 107, 117 and 108 to the output shaft 8.

[032] The first reverse gear results by engaging the synchronizer unit of the clutch K1 and of the brake B; the power is here transmitted by the gears 116, 202, 102, 104, 115, 103, 110, 105, 107, planetary stage, 117 and 108 to the output shaft 7. The second reverse gear is engaged by engaging the clutch K2 and the brake B; the power is transmitted from the input shaft 1 via the gears 116, 202, 102, 103, 111, 106, 107, planetary stage, 117 and 118 to the output shaft 8. In the third reverse gear, the clutch K3 and the brake B are engaged so that the power is transmitted via the gears 116, 202, 102, 104, 115, 103, 203, 112, 105, 107, planetary stage, 117, 108. The fourth reverse gear results by engaging the clutch K4 and the brake B, the power being transmitted via the gears 116, 202, 102, 104, 204, 113, 106, 107, planetary stage, 117 and 108 to the output shaft 8.

[033] In addition, the fifth reverse gear results by engaging the clutches K1 and K, the power being transmitted by the gears 116, 202, 102, 104, 115, 103, 110, 105,

107, 117 and 108. According to the invention, the sixth reverse gear is engaged by engaging the clutches K2 and K, the power being transmitted via the gears 116, 202, 102, 104, 111, 106, 107, 117 and 108 to the output shaft 8. In the seventh gear, the clutches K3 and K are engaged the power being transmitted by the gears 116, 202, 102, 104, 115, 103, 203, 112, 105, 107, 117 and 108. Finally, the clutches K4 and K are engaged for the eighth reverse gear; the gears 116, 202, 102, 104, 204, 113, 106, 107, 117 and 108 here transmit the power to the output shaft 8.

[034] The ratio of the planetary stage is preferably selected so that in the shaft 4-5 in the eighth gear or 2-3 in the fourth gear for the transmission, according to FIG. 1, a uniform ratio range is achieved. One clutch takes part in each open flow up to the fixed gear 7.

[035] In FIG. 3, a specially advantageous bearing arrangement for the countershaft 7 is shown. In the prior art, for the countershaft 7 having the planetary stage P, a costly support is needed in which, on four bearing points, housing walls are concentrated on the bearings so as to transmit the forces. The bearings are inventively arranged so that one bearing point can be eliminated in the housing.

[036] The countershaft 7 is deposited in the transmission housing with a bearing A07 and in a hollow shaft 17 with a bearing B07. Radial forces are transmitted, on one hand, from the bearing A07 directly to the housing and, on the other hand, from bearing B07, via a bearing B17, to the housing. From the Figure is to be understood that the hollow shaft 17 is deposited with a bearing A17 on the countershaft 7 and with the bearing B17 in the housing. The radial forces of the bearing A17 are proportionately transmitted from the bearings A07 and B07 via bearing B17 to the housing; radial forces of the bearing B17 are directly supported in the housing.

[037] In addition, axial forces are transmitted from the shaft 7, via the bearing A17, to the hollow shaft 17 and from hollow shaft 17, via the bearing A07, to the countershaft 7. The axial forces can thus be always assisted in the housing by the bearings A07 and B17. By virtue of the arrangement of the bearing B07 in

the active line of the bearing B17, no added tilting forces act upon the bearing system.

[038] In the inventive embodiment, the output stage can be designed with a longitudinal differential (also disengageable).

[039] The inventive idea makes available for dumpers or loaders transmission having good efficiency and able to transmit high powers. By the construction of the transmission, a great equality of parts can be obtained; most parts needed, except the powershift clutches KV and KR, can have the same construction.

[040] Any structural design, especially any spatial arrangement of the countershafts, of the gears, of the planetary stage and of the shifting elements per se or relative to each other and insofar as technologically significant obviously fall also under the scope of protection of the instant claims without affecting the operation of the transmission such as outlined in the claims even if the designs have not been explicitly shown in the Figures or the description.

Reference numerals

1 input shaft
2 countershaft
3 countershaft
4 countershaft
5 countershaft
6 countershaft
7 countershaft
8 output shaft
17 shaft
102 fixed gear or idle gear RL
103 fixed gear
104 fixed gear
105 fixed gear
106 fixed gear
107 fixed gear
108 fixed gear
110 idle gear
111 idle gear
112 idle gear
113 idle gear
115 idle gear
116 idle gear or fixed gear RL
117 idle gear
202 fixed gear
203 fixed gear
204 fixed gear
KV forward cutch
KR reverse clutch
K1 clutch
K2 clutch
K3 clutch
K5 clutch
K clutch
B brake
G housing
P planetary stage
S sun gear
H hollow gear
SR synchronizer unit or dog clutch
SV synchronizer unit or dog clutch
A07 bearing
A17 bearing
B07 bearing
B17 bearing